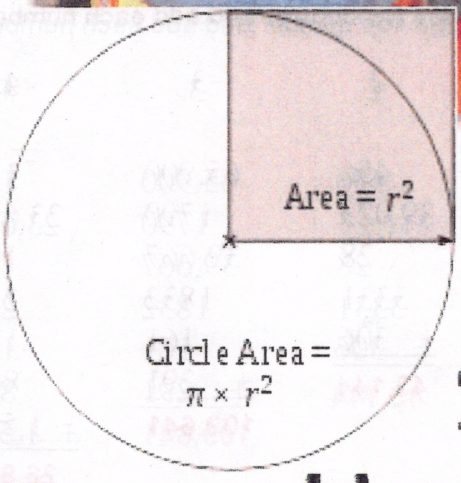
Appendix B
Practical Math Exercises

This section is intended as a *review* of math as it applies to crane operations and was developed for members who may not have strong math skills.

It is <u>not</u> intended as a complete study of all math applications.

Simple calculators are recommended. Programmable calculators are <u>not</u> recommended.



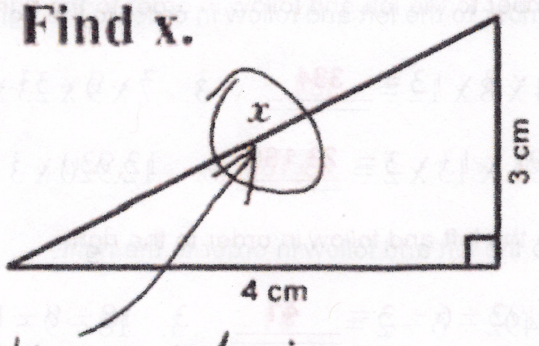
31 ⟌12,012

82
- 77

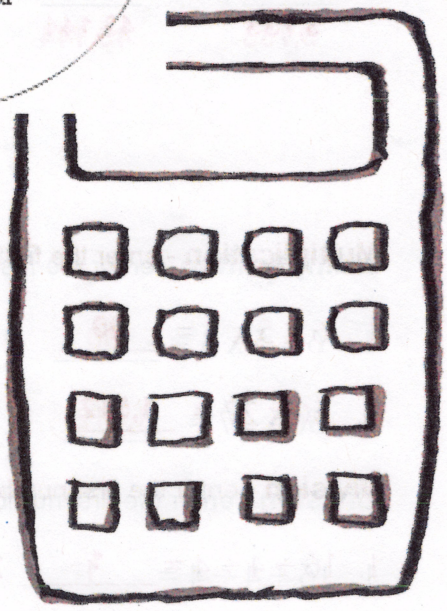
$8^2+2\,(A+A^2)=27$

$\sqrt{6}$ $3\frac{8}{9}$

Find x.



Here it is



Calculator Exercises

Subtraction - enter the top number and subtract each number beneath it successively.

1.	2.	3.	4.	5.	6.
24,700	73,500	741	349,293	56,531	23,987
1,300	31,001	21	2,691	5,271	12,097
300	572	1,029	46,270	4,112	534
- 5,590	- 1,481	- 19	300,002	1,357	1,251
1,751	40,446	-328	- 330	560	90
			0	- 128	- 1,491
				45,103	8,524

Addition - enter the top number and add each number beneath it successively.

1.	2.	3.	4.	5.	6.
67	456	65,900	123	5,500	569,190
2159	39,023	1790	23,691	2,800	29,400
493	28	39,667	147	1,400	31,400
955	3331	1832	258	230	887
+ 59	+ 306	161	159	203	71,934
3,733	43,144	+ 291	861	312	18
		109,641	+ 1,573	+ 59	+ 1,422
			26,812	10,504	704,251

Multiplication - enter the first number to the left and follow in order to the right.

1. 6 x 5 x 3 = 90 2. 4 x 8 x 12 = 384 3. 7 x 9 x 23 x 4 = 5,796

4. 56 x 27 = 1,512 5. 891 x 13 x 2 = 23,166 6. 12,920 x 3 = 38,760

Division - enter the first number to the left and follow in order to the right.

1. 16 ÷ 4 ÷ 4 = 1 2. 492 ÷ 6 ÷ 2 = 41 3. 18 ÷ 9 ÷ 1 = 2

4. 64,000 ÷ 5 = 12,800 5. 3,600 ÷ 8 ÷ 2 = 225 6. 2,675 ÷ 25 = 107

Fractions and Decimals

Fractions

Numbers representing parts of a whole number are called fractions. Simple fractions are familiar: a dime is 1/10 of a dollar. In general, fractions look like this:

$$\frac{1}{10} \quad \frac{\text{(numerator)}}{\text{(denominator)}}$$

Decimals

Fractions can be placed as a value (number) to the right side of a decimal, such as 1/10 = .1 Just as values to the left of a decimal represent increasing units of tens, hundreds, and so on; those to the right of a decimal represent decreasing units of tenths, hundredths, and thousandths.

Using decimals instead of fractions makes it easier to perform mathematical tasks (adding, subtracting, dividing and multiplying).

To convert a **fraction to a decimal**

Divide the numerator (top number) by the denominator (bottom number)

Example: 1/10 to a decimal is 1 ÷ 10 = .1 so .1 is 1/10

To convert a **decimal to a fraction**

Multiply the decimal by the denominator of choice, the result will be the numerator.

Example: .625 x 8 = 5 so .625 is 5/8

The result does not always equal a whole number. You may have to try smaller denominators. There is a point where it doesn't matter when measurement is done with a ruler or tape. We generally don't need anything measured to less than 1/16" so rounding off there would probably be sufficient.

Rounding off - the general rule in rounding is as follows:

* Look at the number to the right of the digit you want to round.
* If the number is 5 or more, round up. If it is 4 or less, it remains the same.

Example: .32815 to nearest hundredth... = .33
.32815 to nearest thousandth ..= .328

When converting fractions to decimals, round of to the nearest thousandth.
Convert the following fractions to decimals:

1/4 = **0.25** 1/2 = **0.50** 3/4 = **0.75** 2/3 = **0.667**

4/5 = **0.8** 5/16 = **0.313** 7/32 = **0.219** 13/64 = **0.203**

Conversions

The first step will always be, **CONVERT ALL INCHES INTO FEET.**

To convert inches into feet divide by 12.

Example: 44 inches divided by 12 = 3.667 feet
6 inches divided by 12 = .5 feet
1 inch divided by 12 = .083 feet

To convert fractions of an inch to feet, first convert the fraction to a decimal, then divide by 12

Example: 3/4 of an inch - 3 ÷ 4 ÷ 12 = .0625 feet
5/16 of an inch - 5 ÷ 16 ÷ 12 = .0260416 or .026 rounded off

Convert the following into feet:

3 inches 0.25 6 inches 0.5 9 inches 0.75

1/4 inch 0.021 5/8 inch 0.052 11/16 inch 0.057

5' 4" = 5.333 7' 8" = 7.667 8' 5" = 8.417

11' 7 3/4" = 11.646 9' 5 3/8" = 9.448

Converting inches into feet will be used throughout this text to calculate load weights. The first step will always be, **CONVERT ALL INCHES INTO FEET**.

Failure to do so is the number one error made in these calculations.

For the remainder of this text, when converting inches to feet, round off to the nearest thousandth.

Example: 2 inches converted to feet = .16666 - rounded off - .167

When estimating weights round the answer up to the nearest pound.

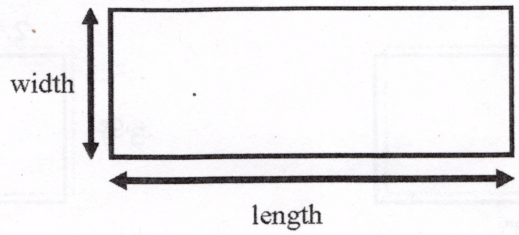
Example: 192.7 pounds - rounds up to 193

Area Formulas

Rectangles

To find the area of a rectangle multiply the length x the width.

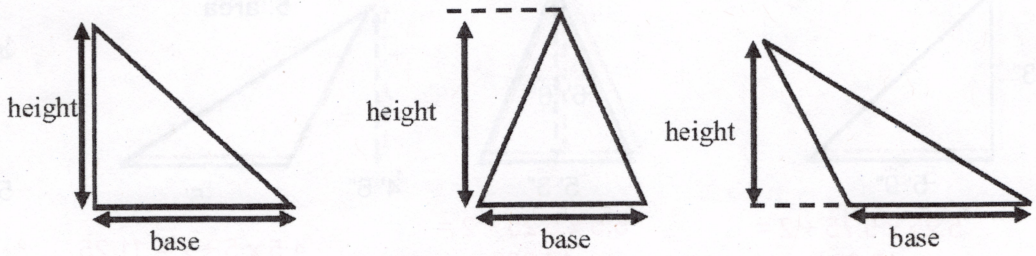
Area = l x w



Triangles

To find the area of a triangle multiply the base x the height and divide by 2.

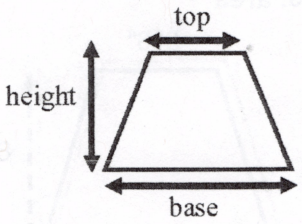
Area = b x h ÷ 2



Trapezoids

To find the area of a trapezoid add the base to the top, divide by 2 and multiply by the height.

Area = b + t ÷ 2 x h



Circles

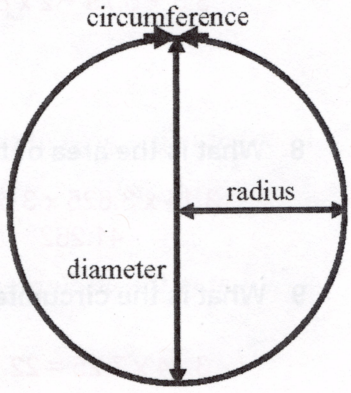
To find the area of circle multiply pi (3.14) x radius x radius.

Area = 3.14 x r x r or 3.14 x d x d ÷ 4

radius = half of the diameter

To find the distance around (circumference) of a circle multiply pi (3.14) x diameter.

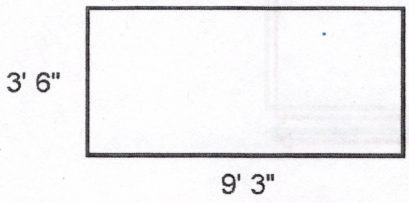
Circumference = 3.14 x d



Area Exercises

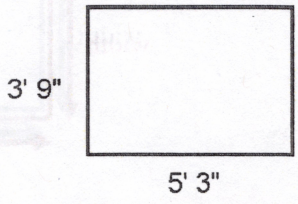
Convert all units of measure to feet. Find the areas of the objects.
Answers should be rounded off to the nearest thousandth.

1. area



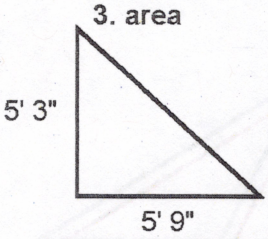
3.5 x 9.25 = 32.375

2. area



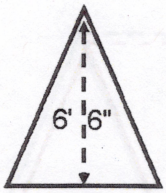
3.75 x 5.25 = 19.688

3. area



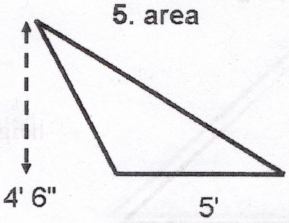
5.25 x 5.75 ÷ 2 = 15.094

4. area



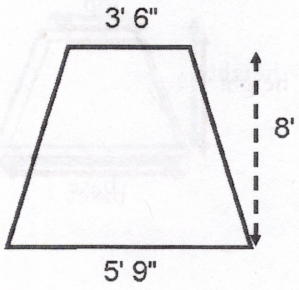
6.5 x 5.25 ÷ 2 = 17.063

5. area



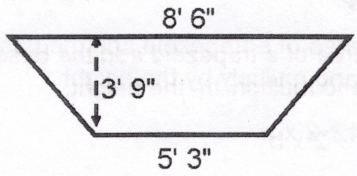
4.5 x 5 ÷ 2 = 11.25

6. area



3.5 + 5.75 ÷ 2 x 8 = 37

7. area



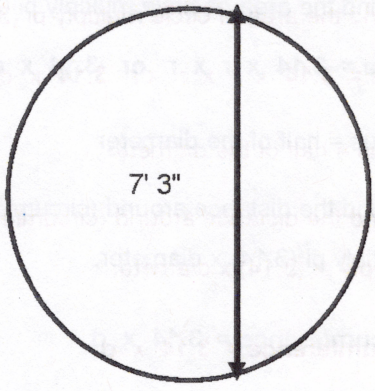
8.5 + 5.25 ÷ 2 x 3.75 = 25.781

8 What is the area of the circle?

3.14 x 3.625 x 3.625 = 41.262

9 What is the circumference of the circle?

3.14 x 7.25 = 22.765



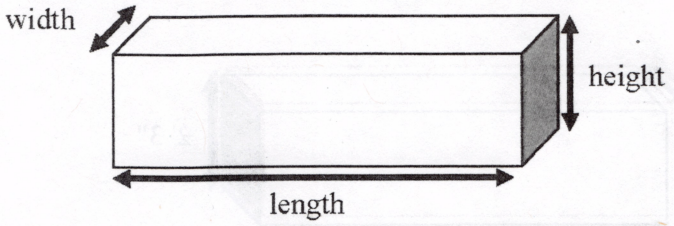
1. 32.375
2. 19.688
3. 15.094
4. 17.063
5. 11.25
6. 37
7. 25.781
8. 41.262
9. 22.765

Volume Formulas

Cubes

To find the volume of a cube multiply the length x the width x height

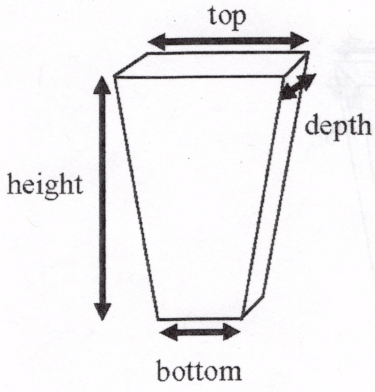
Volume = l x w x h



Odd Shaped Cubes (Trapezoids)

To find the volume of a trapezoid shaped cube add the top + bottom ÷ 2 x height x thickness

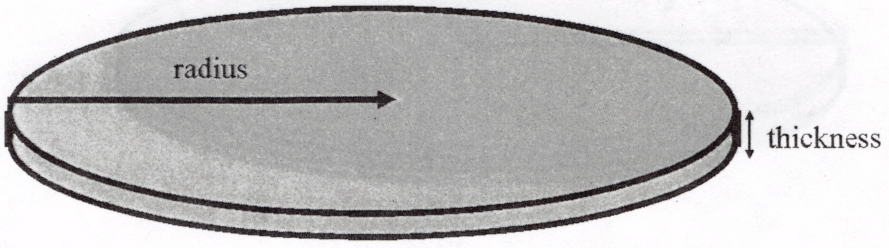
Volume = t + b ÷ 2 x h x d



Round Plates

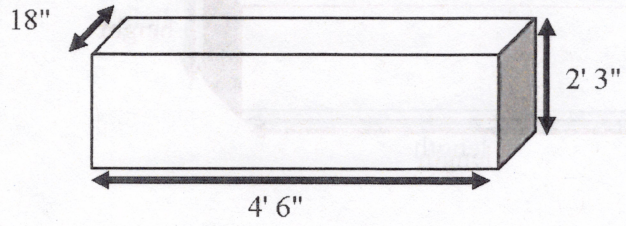
To fine the volume of a round plate multiple the radius x radius x pi x thickness

Volume = 3.14 x r x r x t



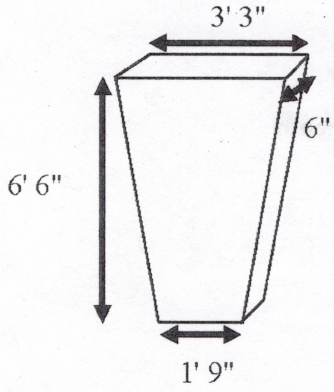
Volume Exercises

Convert all units of measure to feet. Find the volumes of the objects.



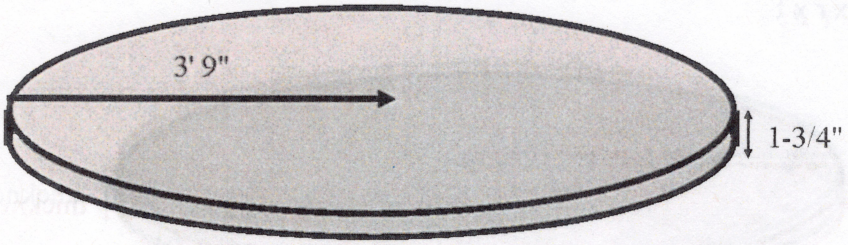
1. **15.188**

4.5 x 1.5 x 2.25 = 15.188



2. **8.125**

3.25 + 1.75 ÷ 2 x 6.5 x 0.5 = 8.125



3. **6.447**

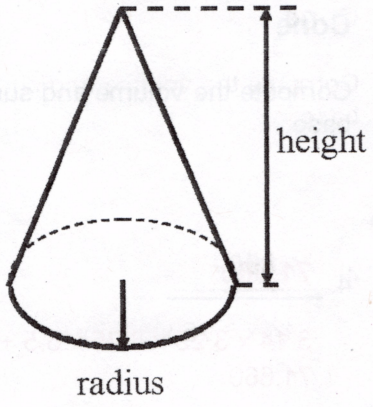
3.14 x 3.75 x 3.75 x 0.146 = 6.447

Volume of Pyramids, Cones & Spheres

Cone

To find the volume of a cone, use the following formula:

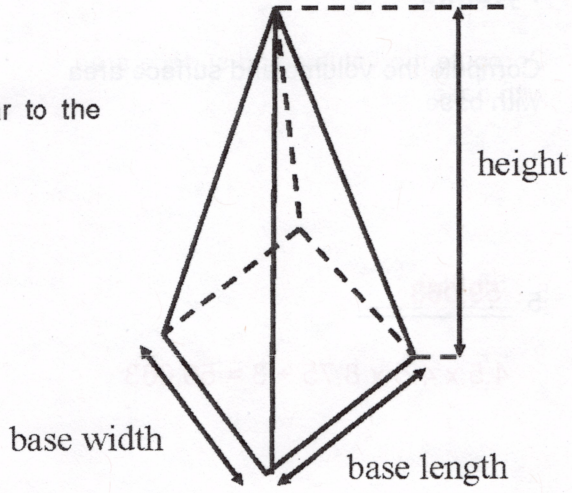
Volume = 3.14 (pi) x radius x radius x height ÷ 3



Pyramid

Finding the volume of a pyramid is similar to the cone, by using the following formula:

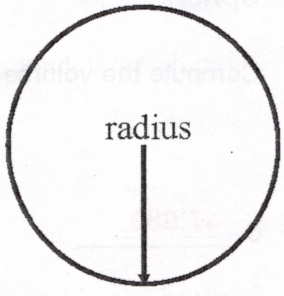
Volume = width x length x height ÷ 3



Sphere

To find the volume of a sphere, use either of the following formulas:

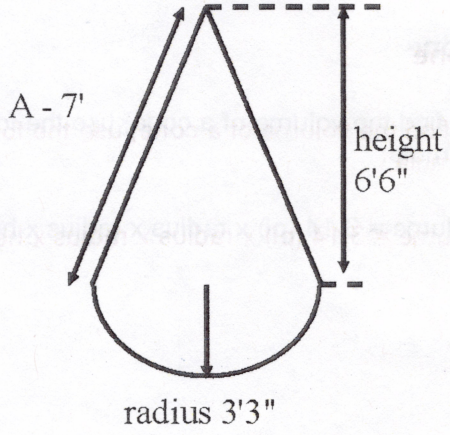
Volume = 3.14 x radius x radius x radius x 4 ÷ 3
or
Volume = 3.14 x diameter x diameter x diameter ÷ 6



Volume Exercises

Cone

Compute the volume and surface area with base.

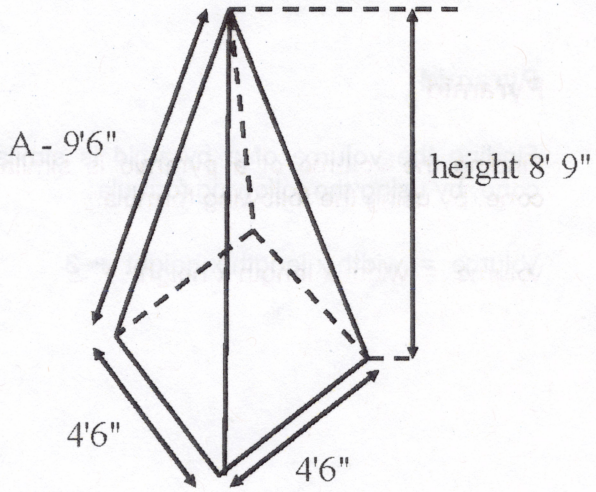


4. **71.860**

3.14 x 3.25 x 3.25 x 6.5 ÷ 3 = 71.860

Pyramid

Compute the volume and surface area with base.

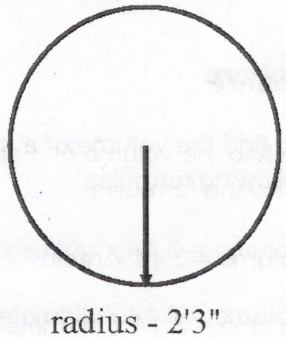


5. **59.063**

4.5 x 4.5 x 8.75 ÷ 3 = 59.063

Sphere

Compute the volume and surface area.



6. **47.689**

3.14 x 4.5 x 4.5 x 4.5 ÷ 6 = 47.689

Estimating Weights

To find the volume of a cylinder, multiply the area of the base x length:

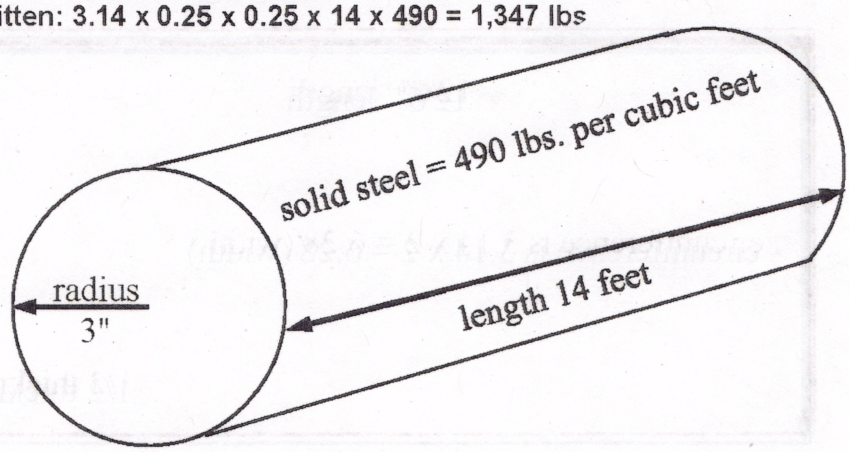
Example:

Volume of a cylinder = area of base x length (which is: radius x radius x pi x length)

0.25 x 0.25 x 3.14 x 14 = 2.7475 volume

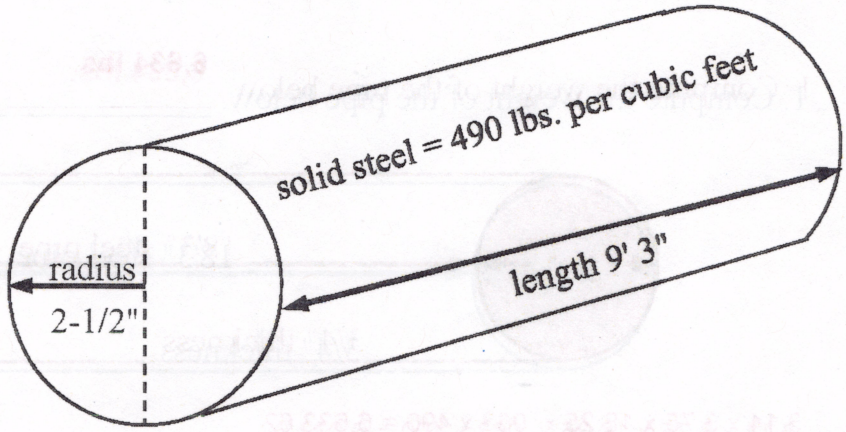
(Volume) 2.7475 x (Weight) 490 lbs = 1,347 lbs.

Equation should be written: 3.14 x 0.25 x 0.25 x 14 x 490 = 1,347 lbs



7. Compute the volume of the cylinder 1.257

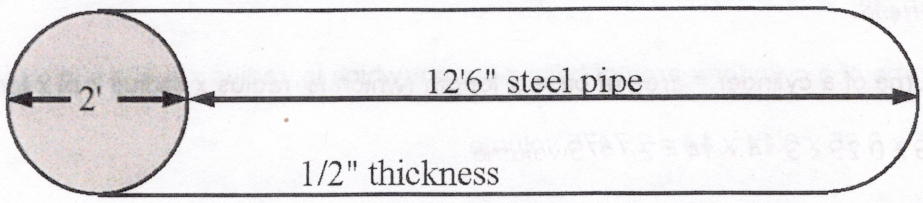
3.14 x .208 x .208 x 9.25 = 1.257



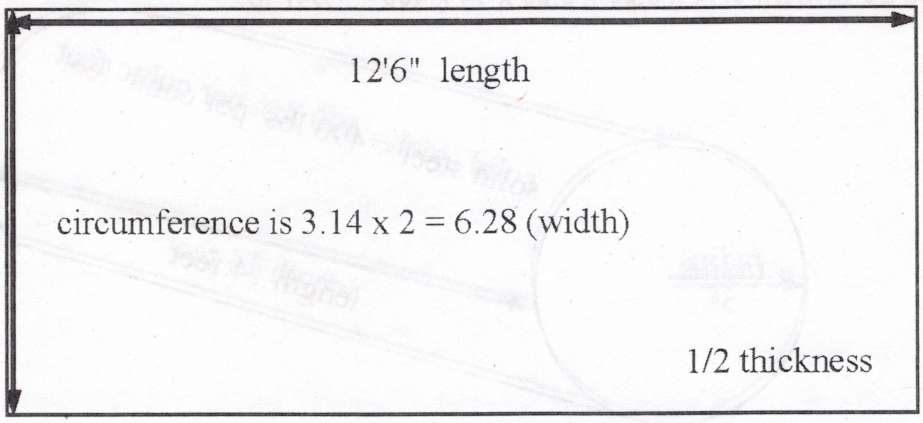
Volume of Pipes

To determine the weight of a pipe, find the surface area x thickness x **unit weight**. (Uw)

Example:



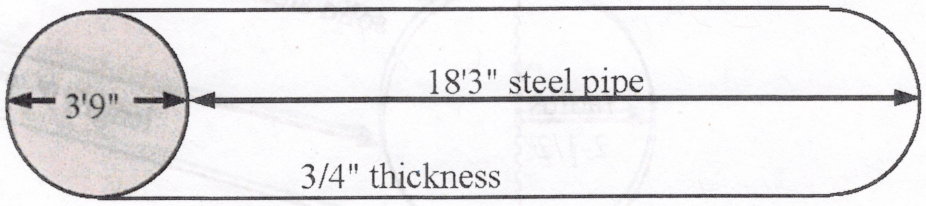
Picture the pipe as if it were cut and laying out flat.



length x width x thickness = volume x unit weight (Uw) = Weight

12.5 x 6.28 x .042 = 3.297 cf x 490 = 1,616 lbs.

1. Compute the weight of the pipe below. **6,634 lbs.**



3.14 x 3.75 x 18.25 x .063 x 490 = 6,633.62

Unit weight of steel is 490 lbs.

Rounds to next full pound.

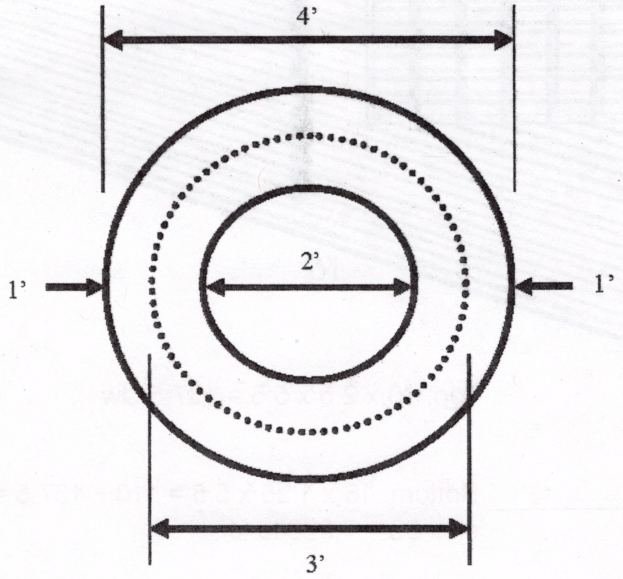
Area and Volume Formulas

Two methods for determining the surface area of a circle with the center removed.

Both of these formulas return volume by multiplying the result x length (or height)

One method includes subtracting the area of the small circle from the large one.

Large:	3.14	x	2	x	2	=	12.56 sf
Small:	3.14	x	1	x	1	=	- 3.14 sf
					The area of the ring is:		**9.42 sf**



Both methods can also be used to determine weight of thick walled pipe.

Take the result, such as our 9.42 then x length x thickness x unit weight as shown on the previous page.

Another method would determine a **centerline diameter** (dotted line) for the ring and use that circumference times the wall thickness as shown on the previous page to determine area. We can subtract the small circle from the large one, then divide by 2 to get the wall thickness of one side which is 1'.

Large Dia.	-	Small Dia.	÷	2 sides	=	Wall Thickness
4'	-	2'	÷	2	=	1'

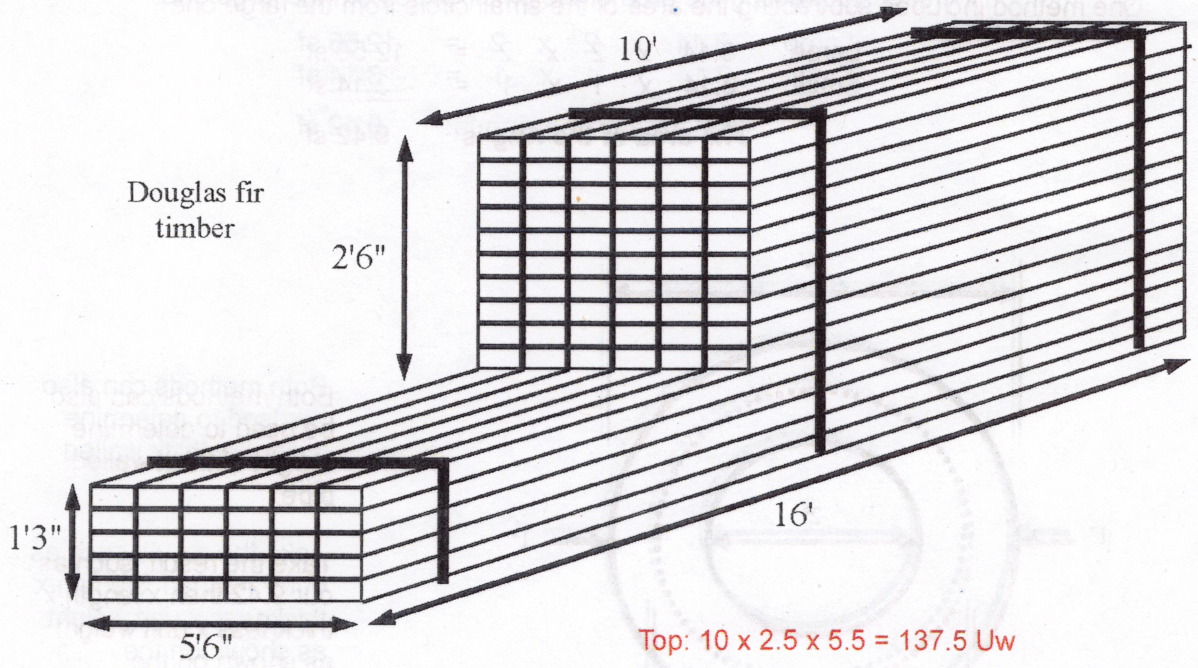
Subtracting 1 wall thickness from the outside diameter gives us a centerline diameter of the ring which we will use.

Pi	x	Dia	x	Th	=	Area
3.14	x	3'	x	1'	=	9.42sf

Estimating Weights

When estimating weights compute the volume in cubic feet and multiple by the "Pounds per cubic foot" listed on the Weights of Materials chart in the back of this Appendix.

Convert all units of measure to feet.

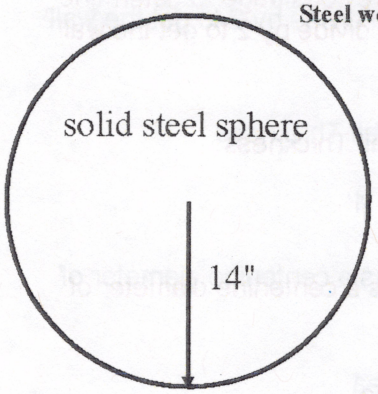


Top: 10 x 2.5 x 5.5 = 137.5 Uw

2. Weight: **32 lb. cf.**

Bottom: 16 x 1.25 x 5.5 = 110 ÷ 137.5 = 247.5 cf. x 32 = 7,920 lb. cf.

Douglas fir timber - **32 lb. cf.**



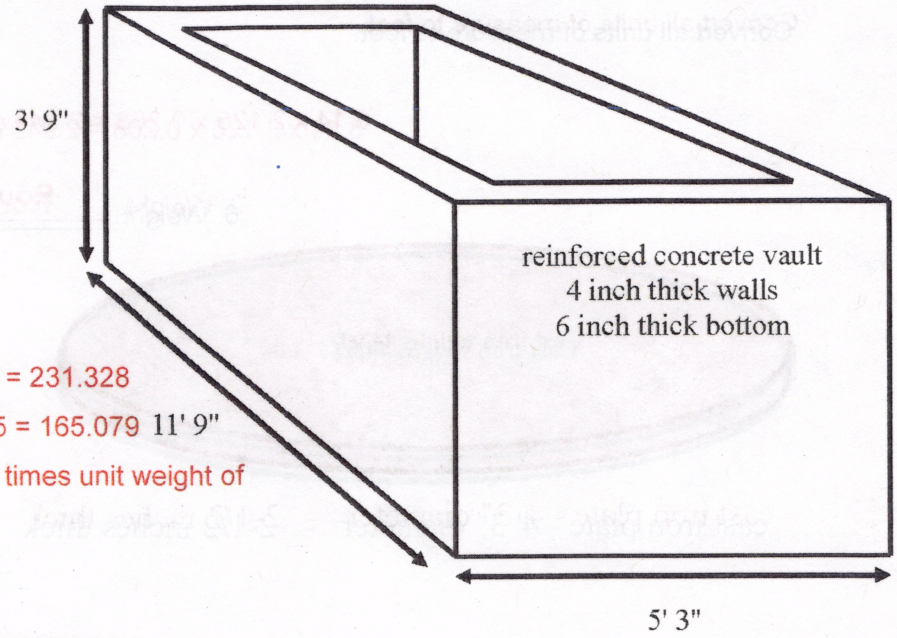
3. Weight: **3,257 lbs.**

3.14 x 2.333 x 2.333 x 2.333 ÷ 6 = 6.645 cf. x 490 = 3,256.05

Estimating Weights

Convert all units of measure to feet.

Concrete weighs 150 lb cf



Outside: 11.75 x 5.25 x 3.75 = 231.328

Inside: 11.083 x 4.583 x 3.25 = 165.079

Subtract inside from outside times unit weight of concrete - 150 lbs.

231.328 - 165.079 x Uw

66.249 cf. x 150 = 9,937.35

4. Weight: Rounds up to **9,938 lbs.**

Top/Bottom: 6.25 x 3.75 x .021 x 2 = 0.984

Sides: 3.75 x 3 x 0.021 x 2 =0.473

Front/Back: 6.25 x 3 x 0.021 x 2 = 0.788

Fuel weight: 6.25 x 3.75 x 3 x 0.75 x 52 = 2,743 lbs.

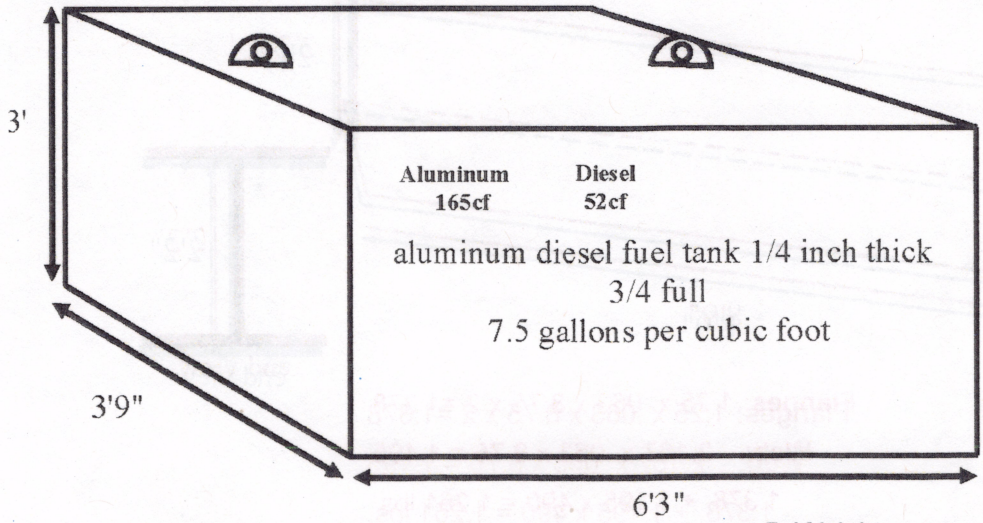
0.984 + 0.473 + 0.788 = 2.245 cf.

x 165 lb.

Tank weight 371

Fuel weight + 2,743

3,114 lb. Total



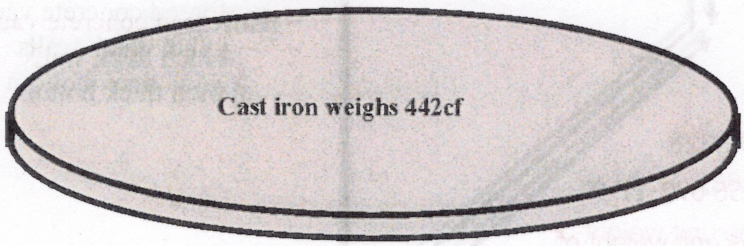
5. Weight: **3,114 lb. Total**

Estimating Weights

Convert all units of measure to feet.

3.14 x 2.125 x 0.208 = 2.949 cf. x 442 = 1,303.458

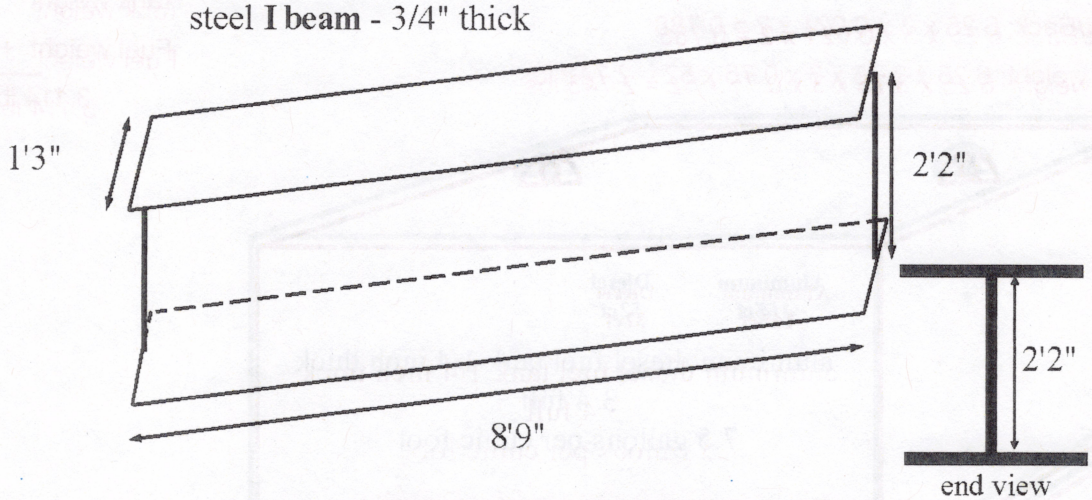
6. Weight: **Rounds to 1,304 lbs.**



cast iron plate - 4' 3" diameter - 2-1/2 inches thick

7. Weight: **1,261 lbs.**

steel **I beam** - 3/4" thick



Flanges: 1.25 x .063 x 8.75 x 2 =1.378

Web: 2.167 x .063 x 8.75 = 1.195

1.378 + 1.195 x 490 = 1,261 lbs.

WEIGHT REDUCTIONS FOR LOAD HANDLING DEVICES

26 FT. BOOM EXTENSION	
*Erected -	1,710 lbs.

*Reduction of main boom capacities

AUXILIARY BOOM NOSE	142 lbs.
HOOKBLOCKS and HEADACHE BALLS:	
25 Ton, 3 Sheave	550 lbs.+
7.5 Ton Overhaul Ball	354 lbs.+

+Refer to rating plate for actual weight.

When lifting over swingaway and/or jib combinations, deduct total weight of all load handling devices reeved over main boom nose directly from swingaway or jib capacity.

NOTE: All load handling devices and boom attachments are considered part of the load and suitable allowances MUST BE MADE for their combined weights. Weights are for Grove furnished equipment.

LINE PULLS AND REEVING INFORMATION

HOISTS	CABLE SPECS.	PERMISSIBLE LINE PULLS	NOMINAL CABLE LENGTH	CABLE/ WEIGHT
Main & Aux.	5/8" (16mm) 18x19 Class or 35x7 Rotation Resistant Min. Breaking Str. 45,400 lb.	9,080 lb.	450 ft.	1 lb./ft.
Main	5/8" (16mm) 6x37 Class, EIPS, IWRC Special Flexible Min. Breaking Str. 41,200 lb.	11,640 lb.	450 ft.	1 lb./ft.

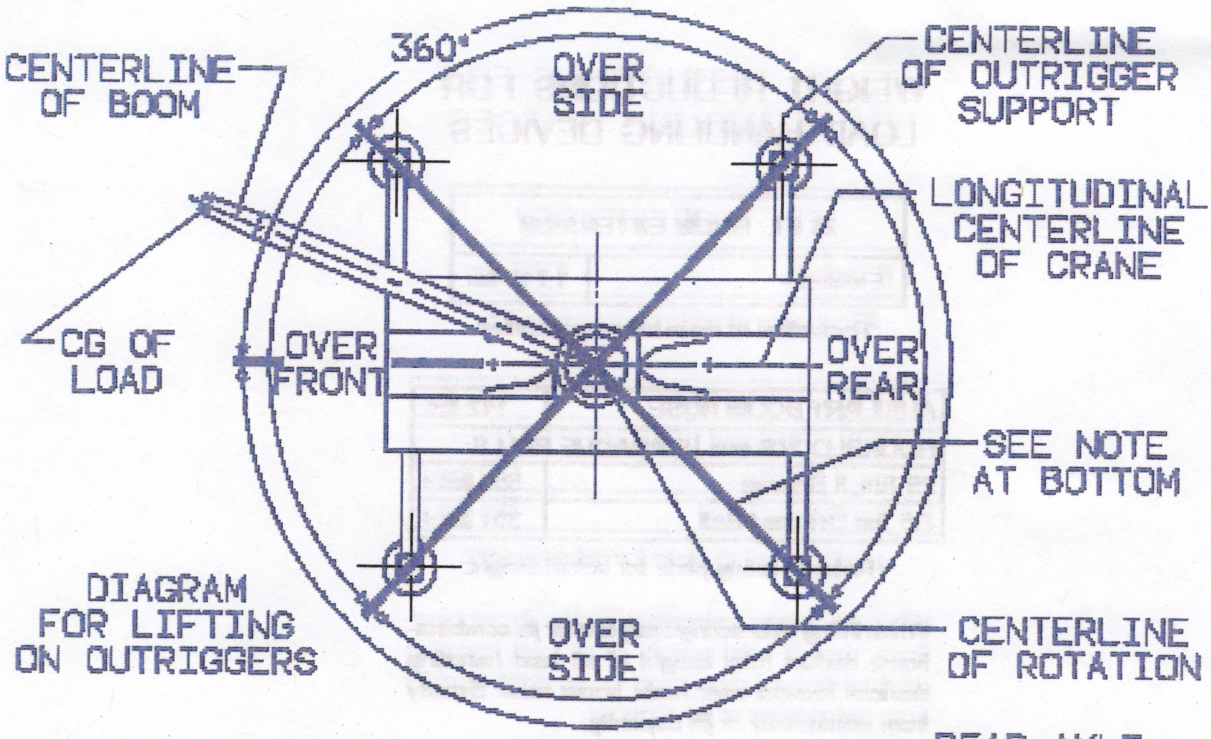


DIAGRAM FOR LIFTING ON OUTRIGGERS

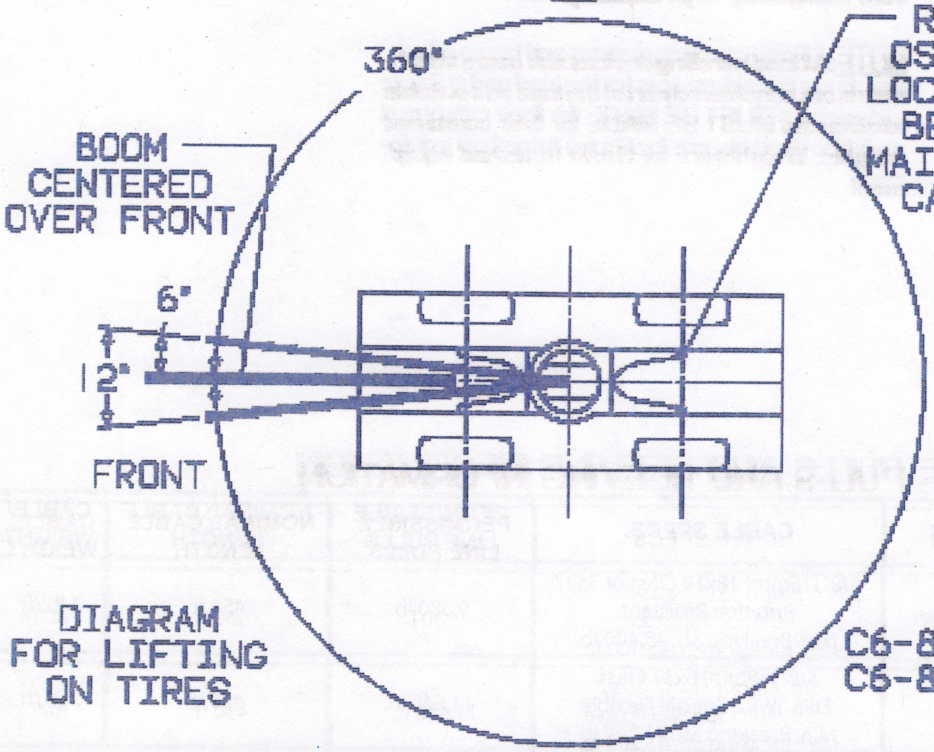


DIAGRAM FOR LIFTING ON TIRES

C6-829-003529
C6-829-001159

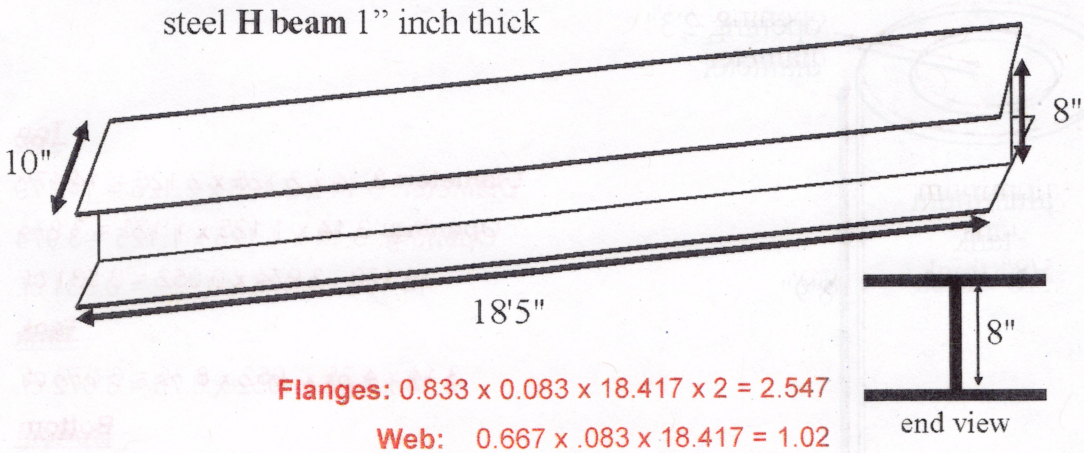
BOLD LINES DETERMINE THE LIMITING POSITION OF ANY LOAD FOR OPERATION WITHIN WORKING AREAS INDICATED

WORKING AREA DIAGRAM

Estimating Weights

Convert all units of measure to feet.

8. Weight: **1,748 lbs.**

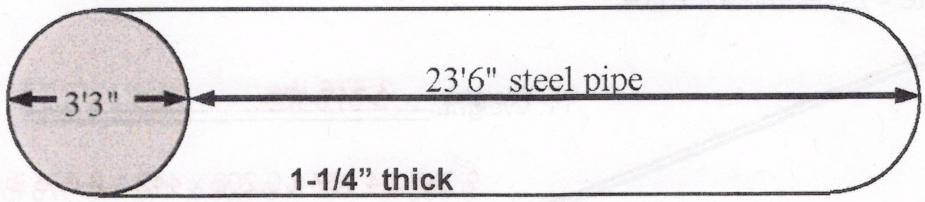


Flanges: 0.833 x 0.083 x 18.417 x 2 = 2.547

Web: 0.667 x .083 x 18.417 = 1.02

2.547 + 1.02 x 490 = 1,748 lbs.

9. Weight: **12,222 lbs.**

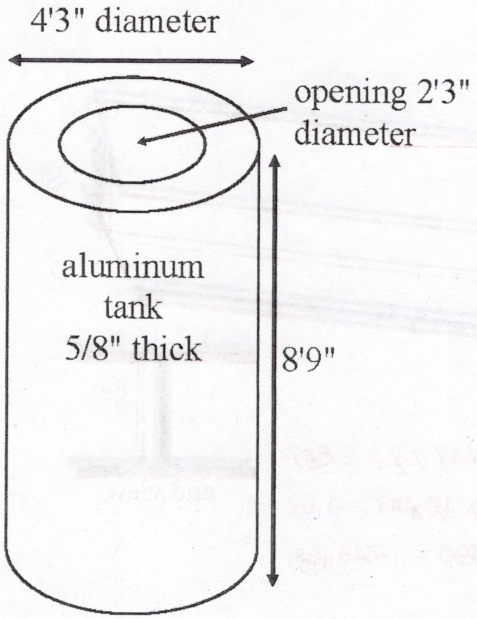


3.14 x 3.25 x 23.5 x .104 x 490 = 12,222 lbs.

A common field practice involves calculating the weight per foot for the different sized beams on a job site and keeping them in a notebook. Weight per foot times length equals piece weight

Estimating Weights

Convert all units of measure to feet.



10. Weight: **1,212 lbs.**

Top

Diameter: 3.14 x 2.125 x 2.125 = 14.179

Opening: 3.14 x 1.125 x 1.125 = 3.974

14.179 - 3.974 x 0.052 = 0.531 cf.

Tank

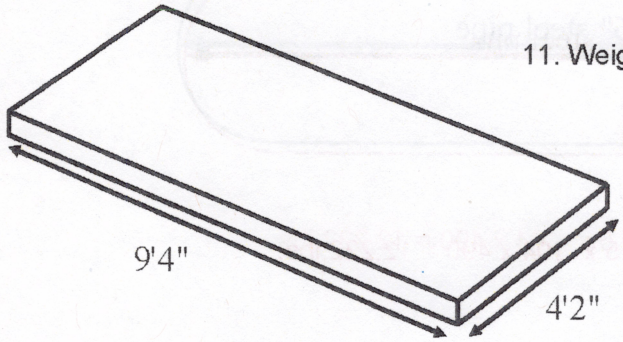
3.14 x 4.25 x .052 x 8.75 = 6.072 cf.

Bottom

3.14 x 2.125 x 2.125 x .052 = 0.737 cf.

0.531 + 6.072 + 0.737 x 165 = 1,212 lbs.

cast iron plate - 2-1/2 inches thick

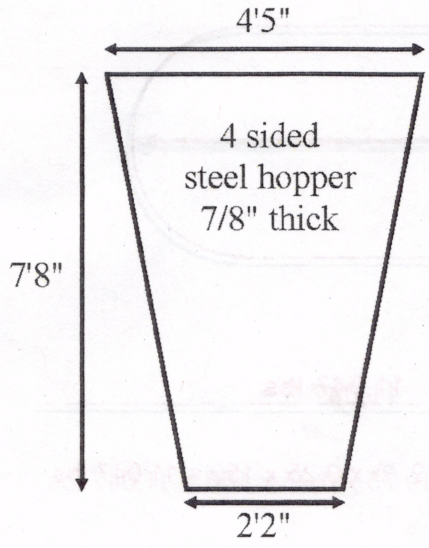


11. Weight: **3,576 lbs.**

9.333 x 4.167 x 0.208 x 442 = 3,576 lbs.

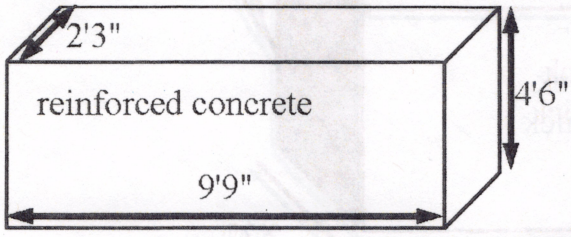
Estimating Weights

Convert all units of measure to feet.



12. Weight: **3,612 lbs.**

4.417 + 2.167 ÷ 2 x 7.667 x 0.073 x 4 x 490 = 3,612 lbs.

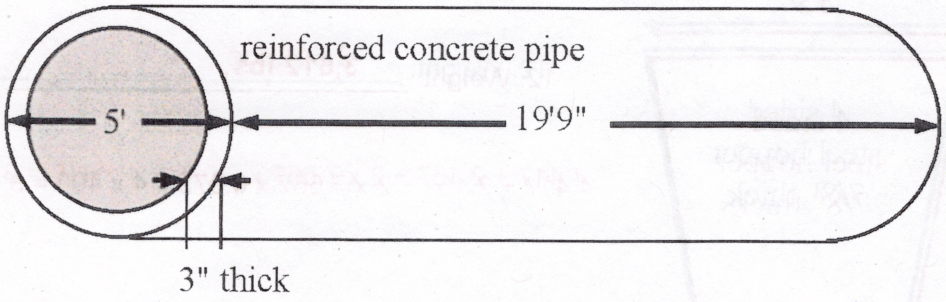


13. Weight: **14,808 lbs.**

9.75 x 2.25 x 4.5 x 150 = 14,808 lbs.

Estimating Weights

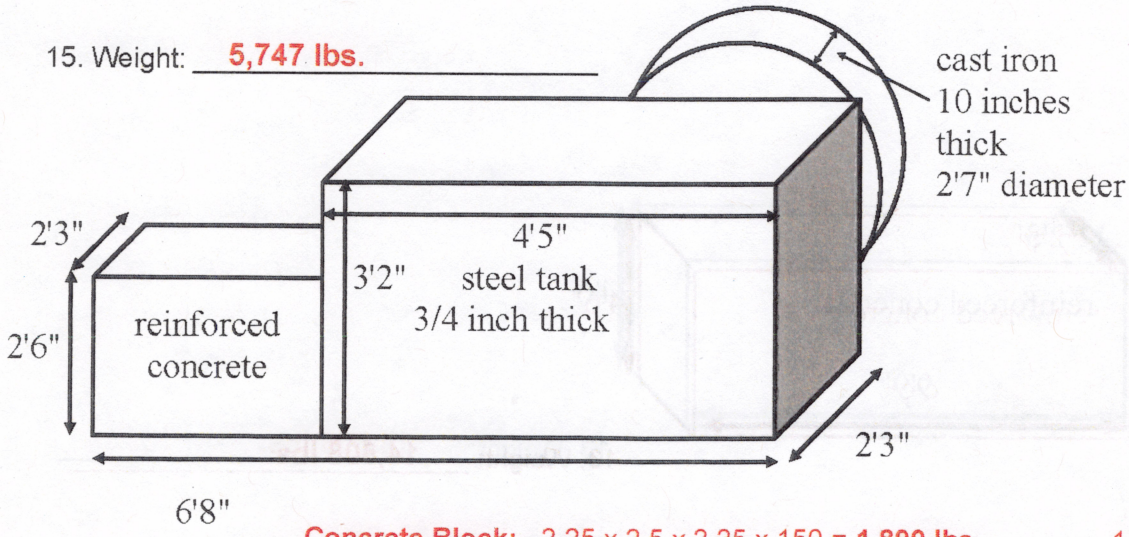
Convert all units of measure to feet.



14. Weight: **11,047 lbs.**

3.14 x 4.75 x 19.75 x 0.25 x 150 = 11,047 lbs.

15. Weight: **5,747 lbs.**



Concrete Block: 2.25 x 2.5 x 2.25 x 150 = **1,899 lbs.** 1,899

Steel Tank: Top/Bottom: 4.417 x 2.25 x .063 x 2 = 1.252 1,918

Sides: 3.167 x 2.25 x .063 x 2 = 0.898 + 1,930

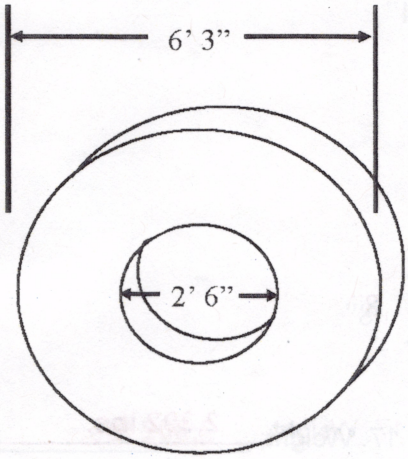
Front/Back: 4.417 x 3.167 x .063 x 2 = 1.763 **5,747 lbs.**

1.252 + 0.898 + 1.763 x 490 = **1,918 lbs.**

Wheel: 3.14 x 1.292 x 1.292 x .833 x 442 = **1,930 lbs.**

Estimating Weights

Convert all units of measure to feet.



4 inch thick concrete ring

16. Weight: **1,287 lbs.**

Big circle minus little circle times thickness times unit weight.

3.14 x 3.125 x 3.125 = 30.664

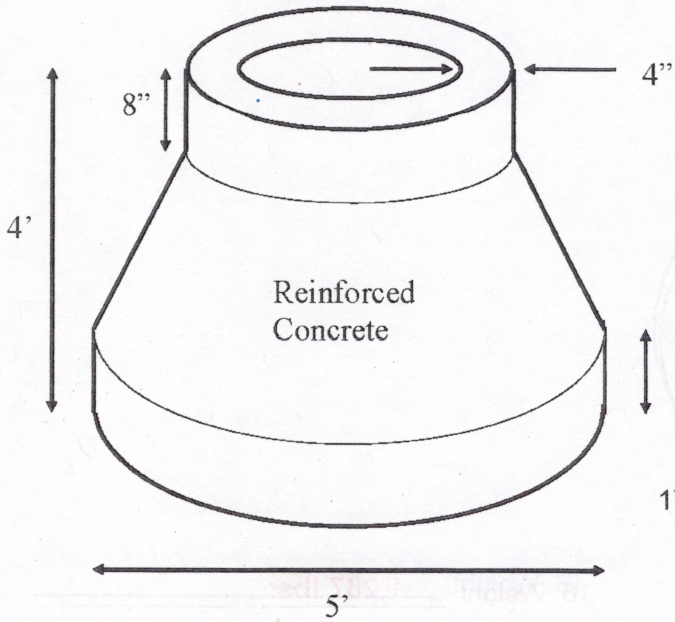
3.14 x 1.25 x 1.25 = -4.906

25.758 sf

25.758 x 0.333 x 150 = 1,287 lbs.

Estimating Weights

Convert all units of measure to feet.



17. Weight: **2,302 lbs.**

Cut the shape into pieces. Use the centerline diameter method, like thick walled pipe.

Figure the mid as a trapezoid to turn it into a straight pipe. Top + Bottom

3 + 5 ÷ 2 = 4'

The top is a 3' ring .667' tall and .333' thick.

Circumference Height Thickness

3.14 x 2.667 x .667 x .333 = 1.86 cf.

The mid section has a 4' diameter by 2.667' tall and .333' thick.

Circumference Height Thickness

3.14 x 3.667 x 2.667 x .333 = 10.226 cf.

The bottom is a 5' ring .667' tall and .333' thick.

Circumference Height Thickness

3.14 x 4.67 x .667 x .333 - 3.255 cf.

Top Mid Bottom cf Uw

1.86 + 10.226 + 3.255 = 15.341 x 150 = 2,301.15 rounds up to 2,302 lbs.

Using the Calculator to find Percentages

To find the percentage of a number, enter that number in the calculator, press x, enter the percentage you're looking for, then press %. This is the standard method used with calculators but doesn't help much without one.

Example: **find 75% of 200**

200 x 75 then press % or **enter ÷ 100** read **150**

To find 100% of a number assigned a percentage value, enter the number in the calculator, press ÷ , then enter the percentage value, then press %

Example: **150 = 75% of** _____

150 ÷ 75 then press % or **enter x 100** read **200**

The find what percentage one number is of another, enter the percentage number in the calculator, press ÷ , then enter the other number, then press %

Example: **25 is what percent of 100** _____

25 ÷ 100 then press % or **enter x 100** read **25**

Calculator Exercises

1. 94% of 26,000 = **24,440**
2. 65% of 43,200 = **28,080**
3. 38 = 20% of **190**
4. 351 = 65% of **540**
5. 15 is what percent of 60 **25%**
6. 72 is what percent of 90 **80%**

Duty cycle ratings, the most common of which is 80%, require percentage calculations when a known weight is to be lifted as a duty cycle load. A loaded concrete bucket is the most common followed by magnets and clamshells.

Lets assume the bucket of concrete shown here, including the weight of the ball and any rigging is 5,000 lbs. A duty cycle rating of 80% is used in the load chart for your crane. What is the total load weight you must look up on the load chart?

The problem would then be: 5,000 is 80% of what?

If 5,000 is 80%, then 5,000 ÷ 80 (finds 1 %) x 100 (rebuilds the whole number).

5,000 ÷ 80 x 100 = 6,250

We would then check the load chart to see at what radius we can swing 6,250 lbs. An optional method which may be close enough with a smaller bucket would be to simply add 20% to the 5,000 lb weight. The easy way to add 20% is to multiply the weight, 5,000 times 1.2. Multiplying a number by 1 returns that number which is what we want to do, but with the 20% tacked on, that is what the .2 does. A number times .2 will return 20% of the number, so, 5,000 x 1.2 = 6,000 lbs. A difference of 250 lbs which will usually not be a factor as concrete buckets are rarely filled uniformly or completely.

5,000 x 1.2 = 6,000 (probably close enough)

Multi-crane picks, hoisting personnel, and company policy safety factors, all require a reduction in rated lifting capacities.

Multi crane picks generally are not more than 75% of either cranes rated capacity. The math then would be the load chart capacity times .75. Example: 10,000 lbs x .75 = 7,500

Company policy may require not handling more than a percentage of the rated capacity. The load chart capacity times the safety factor the company uses will be the useable gross load. The math is the same as that used for multi crane picks. Example: 34,000 x .7 = 23,800

Hoisting personnel calls for a 50% reduction in the cranes' capacity. Simply add up the total load that will be on the crane, then multiply by 2. Our example uses the ball, extension, auxiliary boom nose, and the gross loaded weight of the mancage.

Example:	Headache ball	500 lbs
	Stowed ext.	1,200 lbs
	Aux. nose	250 lbs
	Mancage	+ 4,500 lbs
		6,450 lbs

The 50% reduction can be figured by multiplying the gross load by 2 and using that figure as the gross load to be selected from the load chart. This method assures the crane will not be loaded to more than 50% of its rated capacity.

Percentage Exercises

What is 27% of 4,300 **1,161**

4,300 x .27 = 1,161

4,300 is 20% of ? **5,375**

4,300 ÷ 80 x 100 = 5,375

44 is 22% of ? **200**

44 ÷ .22 = 200

62% of 120 is ? **74.4**

120 x .62 = 74.4

The load chart shows a capacity of 11,640lbs at a 50' radius, how much weight can we pick with an 80% duty cycle rating?

9,312

The load chart notes state the duty cycle for a clam is 80% not to exceed 10,000lbs.

What would the gross capacity shown on a load chart be?

12,500

What weight will I need to look up to determine radius with an 80% duty cycle rating and a total load of 7,500lbs.

9,375

Adding 1,500 lbs to a 12,000 lb load would be an increase of what percentage?

12.5%

1,500 ÷ 12,000 x 100 = 12.5%

A $31,000 car would cost a consumer how much with a 7% tax rate?

$33,170

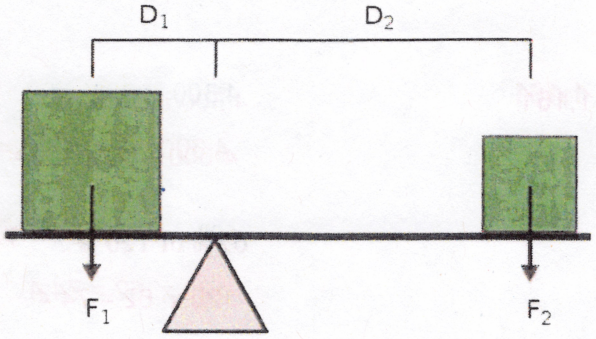
$31,000 x 1.07 = $33,170

With an 8% tax rate, how much will I pay for a can of soup that costs $1.37?

1.48

$1.37 x 1.08 = $1.48

Leverage



$F_1D_1 = F_2D_2$.

The lever, one of the basic tools that dates back to prehistoric times. A beam (lever) is used to move a load with a fulcrum (pivot) and an applied force. The position of the three determines the mechanical advantage.

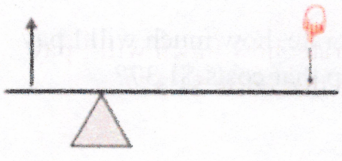
The point where you apply the force is called the effort. The effect of applying this force is called the load. The load arm and the effort arm are the names given to the distances from the fulcrum to the load and effort, respectively. Using these definitions,

The Law of the Lever is:

load arm X load force = effort arm X effort force.

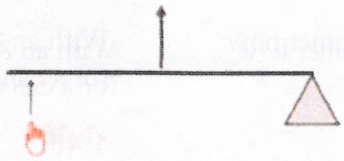
If, for example, a 1 gram feather were balanced by a one kilogram rock, the feather would be 1000 times further from the fulcrum than the rock; if a 1 kilogram rock were balanced by another 1 kilogram rock, the fulcrum would be in the middle.

To use a lever to lift a certain unit of weight with a force of half a unit, the distance from the fulcrum to the spot where force is applied must be exactly twice that of the distance between the weight and the fulcrum. For example, to cut in half the force required to lift a weight resting 1 foot from the fulcrum, we would need to apply force 2 feet from the other side of the fulcrum.



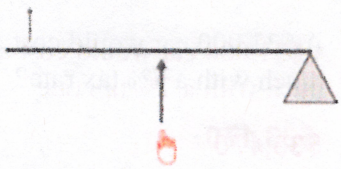
First Class Lever

pliers
see-saw



Second Class Lever

wheel barrow pry-bar

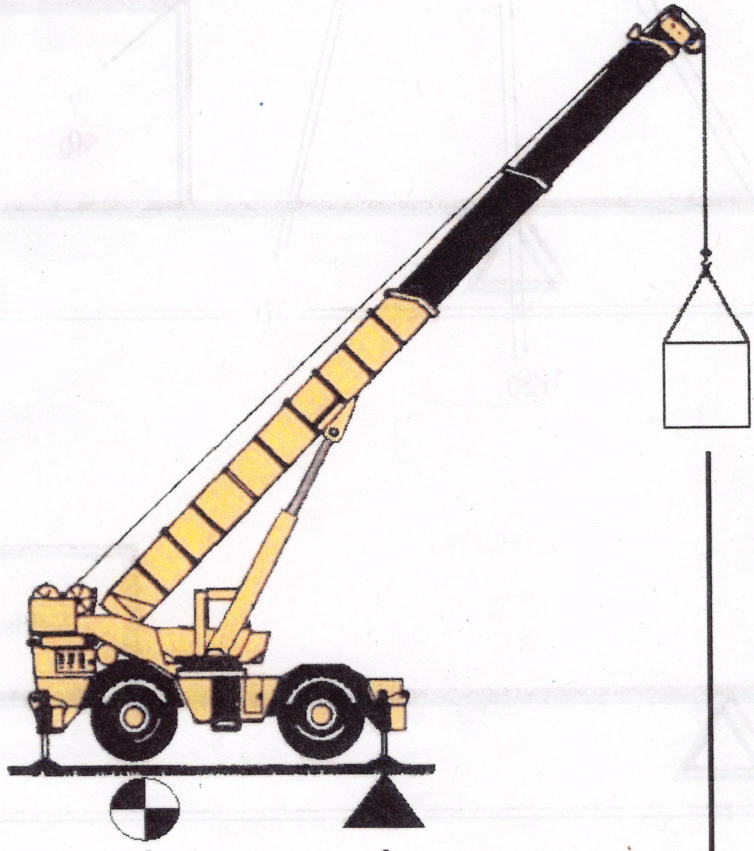


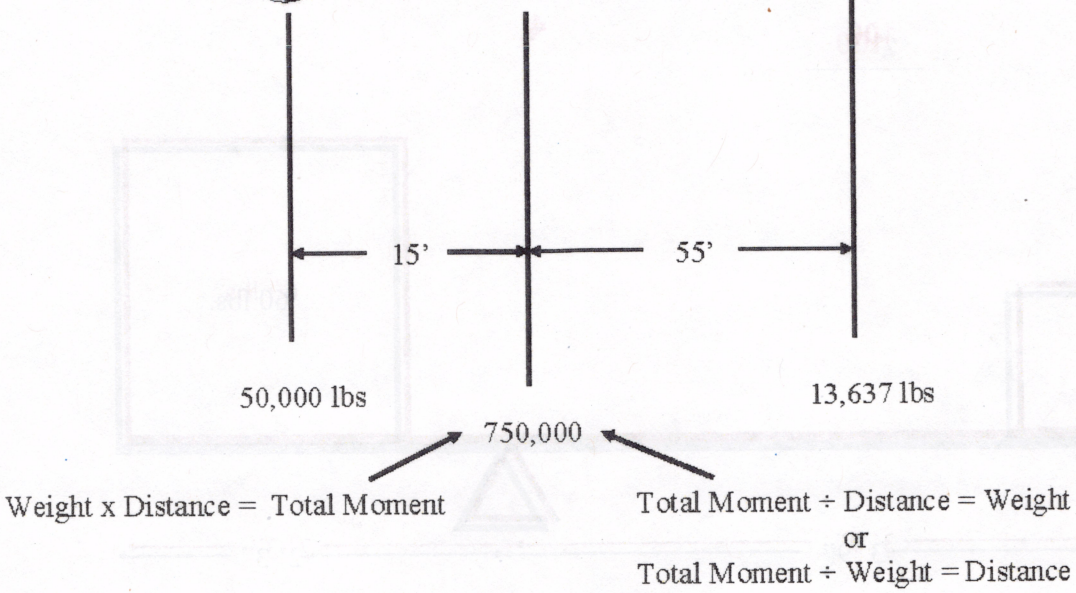
Third Class Lever

hydro-crane
boom fishing pole

The Principle of Leverage

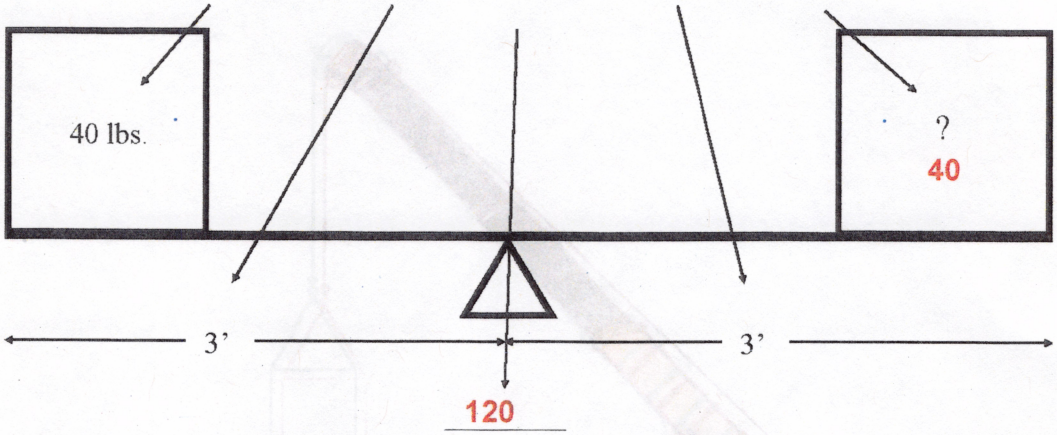
Weight x Distance = Distance x Weight

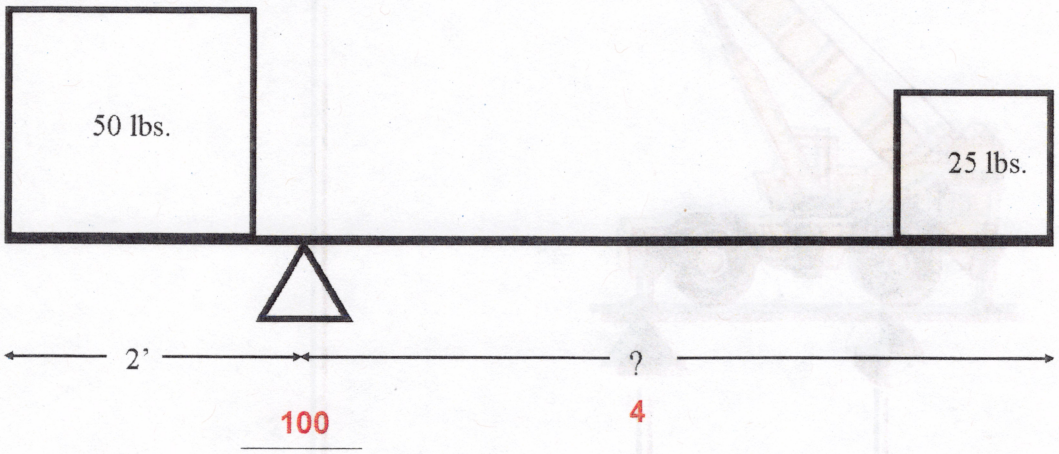


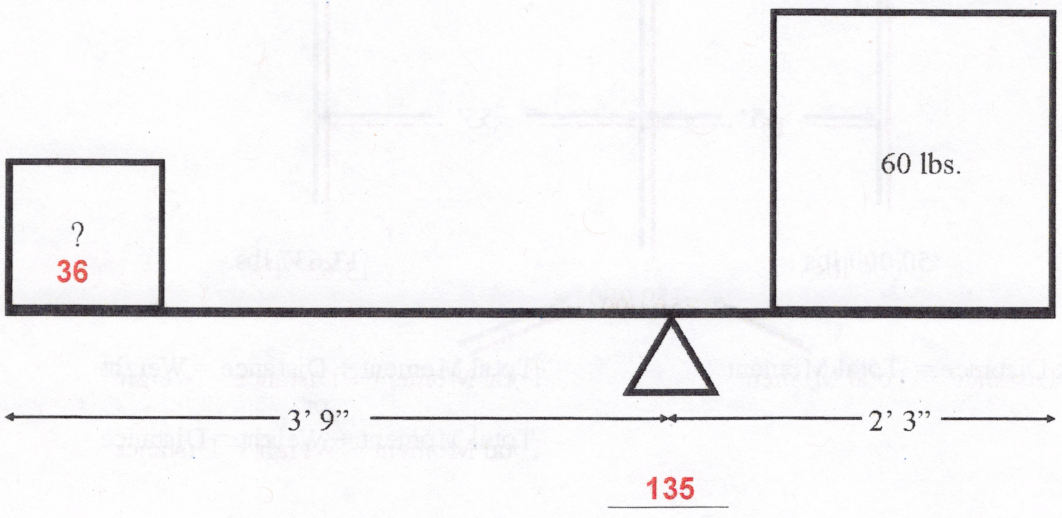


Leverage Exercises

weight x distance = moment = distance x weight







Metric System

This part of the text is not intended to convert you from the standard system of weights and measures to the metric system, but is included for your personal use.

Every country in the world uses the **metric system** although many products are still manufactured in common sizes for public use. The metric system was devised by French scientists in the late 18th century to replace the chaotic collection of units then in use. The goal of this effort was to produce a system that did not rely on a hodge-podge of separate standards, and to use the decimal system (base 10, just like counting money) rather than fractions.

To obtain a standard of length a quadrant of the earth (one-fourth of a circumference) was surveyed from along the meridian that passes through Paris. The distance from the North Pole to the equator was calculated and divided into ten million parts, those parts are called meters. (spelled metre in some countries). The definition of the meter has become more and more precise through the years even though its length has not changed. (ten million meters is 10,000 kilometers.)

kilometer (km)	hectometer (hm)	decameter (dam)	meter (m)	decimeter (dm)	centimeter (cm)	millimeter (mm)
thousands 1000 m	hundreds 100 m	tens 10 m	one 1 m	tenths .1 m	hundredths .01 m	thousandths .001 m
1000.	100.	10.	1.	.1	.01	.001

As you can see from the chart starting at 1 meter and moving in either direction that each unit of measure is 10 times larger or smaller than the previous unit.

To convert from one unit to another can be done simply by moving the decimal point. When converting from a **larger unit to a smaller** unit move the **decimal point to the right.**

When converting from a **smaller unit to a larger** unit move the **decimal point to the left.**
Examples:

25.0 m = 2500.0 cm 25.0 m = 0.25 hm 5 cm = 0.05 m

Convert the following:

15 m = **1,500** cm 23 hm = **23,000** dm

0.54 m = **540** mm 1.9 km = **190,000** cm

This base 10 method continues into metric volumes, weights and temperatures. A liter is the volume of one cubic decimeter of pure water at 4 degrees above freezing (water is most dense at that temperature). A kilogram is how much that liter of pure water weighs. Metric temperatures run from 0° (water freezes) to 100° (water boils).

A conversion chart is included on the next page.

Converting Metrics

WHEN YOU KNOW	MULTIPLY BY:	TO FIND*
inches	2.54	centimeters
feet	30.5	centimeters
yards	0.914	meters
miles	1.61	kilometers
fluid ounces	29.6	milliliters
pints	0.473	liters
quarts	0.946	liters
gallons	3.79	liters
ounces	26.3	grams
pounds	0.454	kilograms

* Answers are approximations

Units of Measure Quiz

20 inches	=	508	millimeters
12 yards	=	10.968	meters
915 centimeters	=	30	feet
121 gallons	=	458.59	liters
30 liters	=	28.38	quarts
322 miles	=	518.42	kilometers
322 miles	=	518,420	meters

Weights of Materials

Construction Materials	Pounds per cubic foot
Portland cement	94
Reinforced concrete	150
Earth - loose, dry	76
- wet, packed	96
Gravel - loose/packed	110/113
Granite	167
Limestone	165
Lumber	
Cedar	22
Douglas Fir	32
Oak	50
Pine	34
Plywood - 4 x 8 sheet	22.5 lbs per 1/4" thickness average
Metals	
Aluminum	165
Bronze	509
Cast iron	442
Lead	710
Steel	490
Liquids	
Gasoline	42
Diesel fuel	52
Oil	58
Water	62.5
Miscellaneous	
1 kilogram = 2.2046 lbs	1 cubic foot = 7.4805 gallons
1 metric ton = 2204.62 pounds	1 gallon = .13368 cubic feet
1 meter = 1.093 yards or 3' 3 -3/8"	1 foot/minute = .3048 meters/minute
1 bar = 14.5038 psi	1 kilowatt = 1.341 hp

To convert wind speed to pounds per square foot:
wind speed x wind speed x .0027 x frontal area = load in pounds pushing against an object.

Math Quiz

1. What does steel weigh per cubic foot?

   490 lbs.

2. Convert 9' 4 3/8" inches to feet.

   9.365

3. What is the formula to determine the area of a circle?

   3.14 x r x r

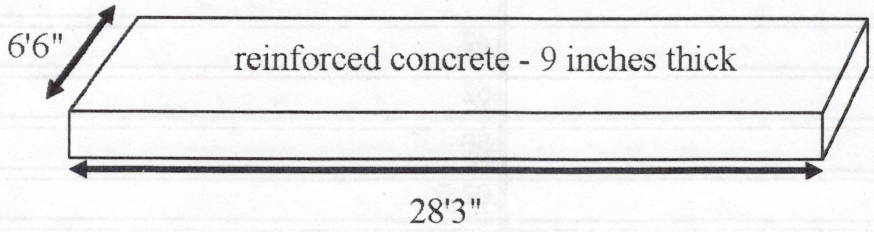
4. What is 35% of 420?

   147

5. Convert 15/16" to feet.

   0.078 ft.

6. Estimate the weight from the graphic below



   20,658 lbs.